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ANNUAL REPORT
OF
THE SOUTH DAKOTA
AGRICULTURAL EXPERIMENT
STATION

for
The Fiscal Year
Ending June 30,
1930

South Dakota State College of
Agriculture and Mechanic Arts
Brookings, South Dakota

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Mr. C. Larsen,

Dean of Agriculture College

Dear Sir:

As director of the South Dakota Agricultural Experiment Station, I have the honor to make the following report for the fiscal year ending June 30, 1930. This includes a brief report of each department of the Station as well as the financial statement by the secretary.

Yours truly,

JAMES W. WILSON,

Director Experiment Station.

ANNUAL REPORT

AGRICULTURAL ENGINEERING

"The Use of the Combine Harvester-Thresher" (Purnell)

Following two years work with the combine harvester-thresher which was used to cut and thresh grain direct, the work this year was done largely with the windrower. The windrower or swather is a machine that cuts the standing grain and lays it down in windrows across the field where it is allowed to cure. When the grain in the windrow has dried it is picked up and threshed by driving the combine through the field and taking up the windrows. A special pick-up attachment is used on the platform of the combine for taking up the windrows. The purpose of the windrow study was to determine:

1. The effect of weeds on the drying out of windrows in the field.
2. The effect of windrowing grain at different times of the day on the rate or drying out in the windrows.
3. The relation of windrow swath to rate of drying out.
4. How early in the day grain can be picked up and threshed from the windrow.
5. The losses for straight combining and windrow methods of harvesting compared.
6. The most efficient rate of travel for picking up windrows.
7. The relation of the width of windrow swath and the size of the combine needed to thresh it.
8. The effect of unfavorable weather on windrows.
9. The time that elapses between the time the binder can be started in the field (also the swather) and the time the grain can be direct-combined.

Summary

For this year's work a field absolutely weed free was used for this study. Cuttings were made at intervals of one and two hours and moisture content determined for each cutting. Different width swaths were cut and checked for moisture. They were also picked up at different speeds and blanket tests made to determine losses in the straw. In a clean field heavy windrows were not objectionable so far as drying out of the grain is concerned. There was less loss in picking up the grain at two miles per hour than when picking up at three miles per hour with all sized windrows. This loss was very heavy on the larger sized windrows.

The combine threshed a swath 4 to 6 feet wider than its cutting width without loss. This was in a field of oats yielding 52 bushels per acre. When the rate of travel was increased or the width of swath extended above this, the losses were increased, both as to shattering and threshing. A fairly heavy windrow stayed in good condition for a period of a month, regardless of ordinary rains. Heavy windrows kept better than the smaller ones as they stayed up on the stubble better. For this year the grain was favorable for direct-combining for a period of 14 days extending from July 26 to August 9. During

this period the moisture was below 15 per cent and the grain was standing up in a satisfactory manner. The season was favorable—just about normal for South Dakota.

This year's work is reported in Bulletin No. 251. The study next year is to be made in extremely weedy grain.

"Corn Harvesting Machinery" (Purnell)

The purpose of this study is to build a stationary corn husker which, when combined with the use of a two-row corn snapper and portable farm elevator, now available, will increase the speed of mechanical harvesting of ear corn over the one-row picker-husker by 100 per cent. The average amount of ear corn that is harvested with the present one-row picker-husker is 205 bushels per day. The average number of men required to harvest this amount is $2\frac{1}{2}$. The above mentioned machine and plan will double the number of bushels harvested per day by increasing the required man-power by one-half of one man.

Summary

All present husking machinery was studied and the fundamental principles of the mechanical corn husker were thoroughly tested. A husking bed set-up was made in the laboratory and tests made to find out the following facts desirable in building the stationary husker; (a) the most efficient diameter of husking roll; (b) the most efficient length of husking roll; (c) the most practical peg for husking rolls; (d) the optimum speed for husking rolls; (e) The optimum angle for husking rolls in the bed; (f) the desirable amount and most efficient type of ear retarders for the husking bed; (g) a practical means of cleaning and saving the corn shelled from the ear in husking.

The following facts have been reasonably well decided from the above: (Other facts have not yet been determined.) The optimum diameter of the husking roll is between $3\frac{1}{2}$ and 4 inches; the optimum length of husking roll for a stationary husker is 36 to 42 inches; the most satisfactory husking peg is a flat headed stud; the optimum speed for husking rolls is 300 R. P. M.; the optimum angle for the husking rolls in the bed is 18 to 22 inches and a machine allowing an adjustable angle to suit the moisture content in the husks of the snapped corn is desirable. One ear-retarder at the top of the husking bed is most satisfactory.

It was found that snapped corn for South Dakota averaged 9 per cent husks, and that these husks can easily be baled for commercial use as they are husked. Work of building the machine is now in progress.

"Rammed Earth for Farm Building Walls" (Purnell)

This study is made for two purposes, the first to do some fundamental research in ramming earth construction, and the second to determine which South Dakota soils are suitable for rammed earth construction. Studies are being made to determine the optimum amount of sand in soils for this purpose, also the optimum amount of moisture in soils having varying amounts of sand. Minor studies are being made on different types of hand rammers, on wall coverings, on different sizes of aggregate, and on reinforcing fiber.

Mechanical strength tests are being given the test specimens or

blocks both in compression and transverse tests. The shrinkage in test specimens is measured and test walls are being built which will we used for a weathering test.

Summary

The studies to date have shown that a considerable amount of sand is necessary in dirt to be used for this purpose and that South Dakota soils generally are lacking in sand. The sand is necessary to absorb the shrinkage stresses as the block dries out. The study to date shows that the allowable moisture content in soils varies inversely as the amount of sand in the soil. A curve is being developed for this and also a curve for optimum moisture in soils with varying amounts of sand.

A supplementary study of foundations for earth walls is being made and a test run to determine the amount of heaving in foundations of various depths due to frost action.

AGRONOMY

Carbohydrate Variations (Purnell)

The results that have been secured from this Purnell project have been tabulated by Professor Puhr during the present year, and are now in fairly complete manuscript form.

With the close of the present growing season, it will be possible to report consistent analyses of carbohydrates as found in the leaves of Indian corn for the following successive seasons: 1927, 1928, 1929.

These analyses include the following: Total sugars, non-reducing sugars, reducing sugars, starches. Likewise the series of corn plants upon which these analyses were made were divided into two groups, one of which was produced under indoor (greenhouse) conditions, and the other in open cultivation.

Two strains of corn have been employed in these investigations. Recently these have been selfed (inbred) strains. One of these strains is known to be early, from the standpoint of maturity; and the other late.

Leaf samples were taken during the day at 3-hour intervals, as follows: 4 a. m., 7 a. m., 10 a. m., 1 p. m., 4 p. m., 7 p. m., 10 p. m., 1 a. m.

It has been predicted formerly concerning these analyses that the total sugar in the leaves of early and late varieties began to increase before 4 a. m. and 7 a. m., reaching a maximum usually about 1 p. m. Conversely starch in the leaves appears to decrease rather rapidly from 4 a. m., and reach a minimum about 1 p. m.

More definite study of the results is now under way, and as before indicated is in manuscript form. It is not attempted here to anticipate the results further, but apparently they will add something to present information about the subject. Such information is tabulated. It appears that considerable opportunity remains yet for the present results and further results which may appear.

Combine Studies (Purnell)

This cooperative project now completed is entitled "A Study to Determine the Comparative Quality of Grain (1) Cut with the Combine Harvester, and (2) Cut in the Usual Method with a Binder, and

Threshed Later with a Threshing Machine after Curing by the usual Methods." During the year now closed the findings of the study have been completed and published in bulletin 244, "Progress Report on the Use of the Combine in South Dakota." The summary of the bulletin calls attention to the fact that the number of combines in use has increased rapidly in South Dakota.

It is further stated the risk of loss due to shattering, hail, and wind, while waiting for the grain to become sufficiently dry for combining, should also be considered as a possible cost.

It is believed that the foregoing bulletin would summarize the results of the cooperative project as originally outlined by three departments. Accordingly, during the present fiscal year the approval of our director was secured for giving special attention to characters in the several varieties of cereal grains—wheat, oats, barley—which would relate especially to the fitness of these varieties for use in areas where combine harvesting is in vogue. In this connection it is possible to point to Ceres as the outstanding variety of hard red spring wheat. A number of other Marquis x Kota crosses have been outstanding in nursery tests. These types have good strength of straw, ability to hold their kernels, and yielding ability.

F2 generations of (Marquis x Kota) x (Marquis x emmer) hybrids are being grown in the field now in attempts to obtain types with a greater degree of resistance to black stem rust.

In the durum wheats a selection of Kubanka has been giving good results. Richland oats is well adapted to combine harvesting. The straw of this variety is, however, too short for its best utilization on dry upland soils or on soils of low fertility. Numerous varieties are under observation for purposes of replacing Richland on such soils. Odessa barley is the outstanding variety among the rough awned barleys, not only from the standpoint of yield, but also from the standpoint of good agronomic characteristics, such as strength of straw and ability to hold its kernels. Several smooth awned types, such as Bay Brewing x Lion (designated as X244), and Velvet, have shown up to good advantage. The smooth awned types have not yielded as high as the rough awned types.

Corn Ear Rots (Adams)

In the previous reports of this project it has been mentioned that the investigation of corn diseases, including ear rots, was begun originally with the use of seed corn of several varieties secured from growers. It was thought possible at the beginning that these corn diseases would appear to be associated with varieties and strains of corn growing in particular geographic areas. As the investigation progressed it seemed less likely that such was the case. It is not attempted here to anticipate conclusions which may be attained, but it later seemed possible that specific corn disease organisms were rather associated with definite homozygote strains. The necessity for careful observation in establishing any such correlations is obvious.

Within the present fiscal year attention has been given by Mr. Franzke and Mr. Hume to making germinations of corn intended for experimental planting under known temperatures. A constant tem-

perature apparatus has been utilized for this purpose. It appears that the rapidity of germination of corn is not only affected by the degree of temperature, the fact of course well known, but likewise by the rapidity with which specific moulds that may be present is also affected. The use of lower temperatures, especially for germination has made certain observations possible that were difficult or not at all possible before.

SOIL FERTILITY (ADAMS)

Under the foregoing heading one long-time project is conducted which is designed to give information about the differential effect on different rotation systems and cropping treatments upon the fertility content and condition of soil. This project involves a set of permanent rotation plots from which samples are taken at stated intervals, with a view to determining from the analyses of such samples whether changes are produced in the fertility condition of the soil of the several plots.

During the present year field tests have been carried out according to the project, crops grown and yields recorded. The twenty plots in this project were sampled during the summer of 1929, twelve borings per plot being made; samples dried and stored. Nitrogen determinations made on all the samples.

Sulphur and Phosphorus (Adams)

A project to determine definitely the effects of phosphorus in different forms on the growth of plants and the effect of sulphur in combination with calcium (gypsum, calcium sulphate), and as pure sulphur on the growth of plants, and its effect—the availability of phosphorus in different forms.

The plan of the project, as already reported, is to observe specially prepared vegetation plots including tumbler cultures treated with phosphorus and sulphur and combinations. Observations and measurements of crop yields were taken from these, and also approximately 200 analyses made for water soluble.

During the present year, sand cultures indicate rock phosphate less soluble than other forms for wheat.

Corn Breeding (Hatch)

Within the fiscal year has been published bulletin No. 245, "The Possibility of Utilizing Selfed Strains in Practical Corn Improvement." This bulletin contains a report of annual and average yields of corn from three separate systems of ear-row selection: (1) mass selection, (2) selection by the Illinois (Hopkins) system, (3) the Ohio Remnant system (Williams), for a period of 17 consecutive years.

Continuous ear-row selection of corn for yield 17 successive years (with the use of three separate systems) reinforced the idea that such selection is a means of picking out superior strains, but not in and of itself a sufficient means for genetic improvement.

The foregoing in a measure furnished a statistical basis for the assertion that it would be necessary to utilize hybrid vigor in securing maximum yields of corn.

The row yields produced in 1929 by all Dakota Breeding Plat from near hybrids (S5 strains x Selection 1210) were 25 per cent higher than yields from selected strains.

The evident necessity for devising a system for corn breeding which will involve hybrid vigor, led to the attempt to quote a plan for utilizing selfed strains with perpetual crossing of such strains.

Futhermore an attempt was made in this bulletin to put down steps in a logical system for corn improvement which would make room for the utilization of close-bred strains such as are now developed in ear-to-row systems of breeding involving also the annual crossing of such strains.

High Protein Corn (Hatch and Station Local)

Continuous selection of a strain of corn for high percentage of protein is continued. Such selection apparently gives an increase in the percentage of raw protein found in grain, a fact which in itself is fairly well worked out. This selection is continued not so much merely to discover an increase in percentage of protein but rather to preserve the material for further investigation and analysis. It is hoped that it will be possible in time to make a more definite study of the character of this high protein strain of corn. Formerly (bulletin 153) it appeared that this high protein strain produced not only a higher percentage of protein but a greater yield per acre of protein than the opposite low protein strain. At present writing this does not appear to be the case, due perhaps to gradual reduction in yield of the high protein strain. This selection work is in direct charge of Professor Fowlds.

Selfing for High and Low Eared Strains (Hatch and Station Local)

That which is stated foregoing about the continuance of selecting corn for high protein may be said in regard to continuance of high and low eared strains. Selection has been continued until the average height of ear on the high strain is 52.4, and the average height of ear on the low strain is 8.9. These strains were originally selected from the same general population of South Dakota 86 corn. Likewise it may be possible later to give more time and attention to analyzing the characters of these selected strains.

Breeding Hulless Oats (Hatch)

Several years ago tentative statements were put down concerning Fowlds Hulless oats. (bulletin 205.) Since that time, including the present year, these oat breeding experiments have been continued. Progress is indicated by the following statement from Professor Fowlds:

"The first crop was made in 1917, and the F1 grown in 1918. The Kilby Hulless oat, a local name for the Chinese Hulless oat, was used as the pollen parent. A naked selection from this cross was distributed as Fowlds Hulless, described in bulletin 205. This variety was susceptible to rust and later proved to be very susceptible to smut. This variety was very similar to the Liberty Hulless which was distributed from Canada. Breeding work was continued by crossing the Fowlds Hulless on other hulled varieties. Many crosses were made but all of the promising selections came from a single line of crosses. This line was developed by crossing Fowlds Hulless on Richland. A naked selection from this cross was again back-crossed on Richland. A selection from this was crossed on Markton. The hulless selections

from the latter cross therefore inherits the naked character from Kilby, resistance to stem rust from Richland, and resistance to smut from Markton.

This series of selections like all the parent varieties has no resistance to the leaf rust of oats. When naked and hullless varieties of oats are inter-crossed the F1 are intermediate, and the F2 segregate for the naked character is not clear cut. Nearly all of the naked selections continue to segregate to a slight extent for the hulled character. This necessitates some reselection before the homozygous condition is attained. Although a small percentage of hulls does not injure the oats for purposes of feeding, it is very desirable to procure homozygous selections for seed productions."

Crop and Culture Experiments (Hatch)

Under the foregoing heading have been continued a number of long time valuable crop rotation trials, tests of varieties and strains involving not only commercial ones, but likewise such as have been developed under close observation at this experiment station and elsewhere; experiments with various depths of tillage.

Weed Eradication (Station Local)

It is increasingly recognized that as cropping systems grow older weed eradication and control is one of the most important phases of all farming. Studies of methods of control for specific weeds is therefore of increasing interest.

Some definite information is secured concerning weed control in relation to the crop rotation and tillage experiments that have already been mentioned. The following weeds have been under observation: Quack grass, creeping jenny, perennial mustard, and Canada thistle.

Chemical methods of weed control, especially with the use of chlorates, is being investigated.

Potato Experiments (State Special)

Until the season just opening, tests of growers strains have been conducted annually, as a part of a program for the selection and development of disease-free seed stocks in South Dakota. Obviously the experimental purposes in developing such disease-free seed stocks is to arrive at methods whereby such a desired object can be accomplished. It was decided by this department and by Dr. Klages in conference with the potato growers that the desired objects would be promoted by developing an increased number of strains that were tuber indexed. These strains consist of the following: Irish Cobbler and Triumphs.

Flax Investigations (Contribution)

Flax investigations have been conducted annually for many years in connection with regular rotation and culture experiments. More recently the amount of attention possible to give to flax problems has been enlarged with the use of some scholarship funds. Among the earlier results having a profound effect upon flax culture was the discovery that the optimum date for seeding flax in South Dakota is on or about April 15. Obviously there is variation in such a result, but the average advantage from seeding seasonably has been great enough to have tremendous effect in increasing the surety with which flax may be produced in South Dakota as a regular part of cropping systems.

It has recently been pointed out by Dr. Klages that the variability in yields of flax is statistically higher than that of cereals. It seems possible that such variability may be possible of reduction as a result of seeding flax at an optimum date.

Experiments for discovering the optimum amount of seed per acre are continued. Previously the maximum amount employed experimentally was 20 quarts, which also appeared to be the optimum. Two years ago the experimental amount was increased up to 25 quarts, and the indications are that seeding even more than 20 quarts in usual crop rotations would be profitable.

Such cultural investigations as the foregoing are now supplemented with nursery investigations for discovering the influence of spacing on flax plants individually and collectively. Generally speaking an increase in distance apart of spacing flax plants (which obviously might correspond to thinner seeding) results in a greater amount of branching. Such branching might be termed "bushing." Accordingly one possibility might be that "bush" flax could be produced merely by planting ordinary flax with wide spacing.

During the present fiscal year a half-time student assistant has been employed on flax problems with especial reference to "The Water Requirement of Flax at Different Stages of Growth of the Flax Plant." This problem was assigned to student W. K. Soule, reporting directly to Dr. Klages. An additional flax problem was assigned to senior student Albert Sander: The Water Requirement of Flax."

At the suggestion of the writer Dr. Klages is arranging a further problem with Mr. Soule at the present time, for a study of the effect upon flax plants of competition from different kinds of cereal plants—wheat, oats, barley—when cereal-flax mixtures are seeded.

Flax for Disease Resistance (Contribution)

An increased number of flax selections are being made with a view to finding strains that are resistant to disease, such as wilt and pasmo.

Seed Testing (State Special)

Seed laboratory tested 3,275 samples of seed, and 308 weed specimens were identified.

Substations: Highmore, Eureka, Cottonwood, Vivian (State Special)

The definite outline of culture and rotation experiments, and fertility trials are continued at substations. In some instances these are original experiments and in many cases they supplement research and experimental results arrived at under federal projects at Brookings. Obviously experiments carried out at the several substations are designed to find the answers to questions which are influenced by the ecological conditions of specific areas. Rainfall, soil, and temperature conditions vary.

Within the present fiscal year cooperative arrangements have been resumed at Brookings, Highmore, and Eureka, for cereal breeding. This cooperation is arranged with the United States Bureau of Plant Industry, Office of Cereal Crops and Diseases. The cereal breeding station of this office is located at Redfield, S. D., the work there being also co-

operative with this department. The cooperation indicated makes consultation possible relative to the carrying out of problems in breeding rust resistant cereals, especially wheat, and also makes it possible for our experiment station and substations to secure varieties and strains of cereals that need to be tested under various conditions. Notable among these are several wheat-emmer crosses, along with many others.

Experimental results from numerous trials carried out at substations are published in bulletins relating to the several soil and crop projects. During the present fiscal year results of flax experiments at Highmore, Eureka, and Cottonwood, were published along with those at Brookings in "Flax Facts". At present a manuscript is prepared to submit for publication as an experimental station bulletin entitled "A Decade of Crop Yields from Vivian Farm."

The following is a list of bulletins and circulars issued during the fiscal year just closed:

S. D. Exp. Sta. Bulletin 245—"The Possibility of Utilizing Selfed Strains in Practical Corn Improvement."

"Geographical Distribution of Variability in the Yields of Field Crops in the States of the Mississippi Valley"—K. H. Klages, published in Ecology, April, 1930.

"Effect of Certain Injuries to Leaves of Corn Plants upon Weight of Grain Produced"—A. N. Hume—published in Journal American Society of Agronomy.

"Flax Facts"—Extension Circular 293.

"The Eradication of Field Bindweed"—Klages (mimeograph circular)

"An Example of Quack Grass Eradication"—Hume (mimeograph circular)

ANIMAL HUSBANDRY

How Can Soybeans be Fed With Corn to Avoid Soft Pork?—(Purnell)

Five lots of pigs were self-fed various combinations of corn, soybeans and tankage in dry lots. Each lot was allowed minerals. When pigs reached marketable weight of 225 pounds, they were killed in the college abattoir and the carcasses graded for firmness. Fat samples were taken for chemical analyses.

When soybeans comprise 12 per cent of the grain portion in the corn, soybean, tankage and minerals ration, soft pork is produced, although a fair rate of gain results. If the tankage is omitted, this ration is inadequate for proper growth and health. If the soybeans are omitted, much better gains are observed and very firm carcasses are produced. Ground soybeans of Manchu variety are very unpalatable, while tankage is well liked by growing pigs.

Factors in Feeding Spring Pigs for Market (Hatch and Statton Locals)

Seventy-two spring pigs were divided into nine lots. Eight lots were fed comparatively, on shelled corn, ground barley and ground rye without supplements and on the same feeds with supplements. One lot was fed in dry lot on shelled corn and a supplement as a check.

Four years' work have been completed on this project and the results are being tabulated for publication.

Cheaper and more rapid gains were made by feeding the same supplements with shelled corn, ground barley, on rape pasture than by feeding the same feeds without the supplements. Ground rye gave comparatively poor results.

Number of Cattle, Hogs and Sheep that can be Grazed on an Acre of Yellow Sweet Clover, White Sweet Clover, Alfalfa and Sudan Grass (Hatch and Station Local)

Four lots of fall pigs were put on yellow and white sweet clover pastures. One lot on each pasture was grazed without grain and one lot on each pasture was given a limited amount of shelled corn. This project was conducted through two previous years. The sweet clover made a very rapid growth during the early part of 1929 but after it was clipped to hold it back, failed to make further satisfactory growth.

Flax Straw For Cattle (Station Local)

To determine the value of flax straw for steers and pregnant cows, 24 head, 12 steers and 12 cows, were fed, in four lots of six head each, on different rations containing flax straw plus a limited grain ration.

The results of the first trial show that good flax straw did not cause balls to form in the stomach or cause calves to be born prematurely, as claimed by some.

This trial will be repeated during the fall and winter of 1930-31.

How Many Cattle can be Grazed on an Acre of Alfalfa, Yellow Sweet Clover, White Sweet Clover, Sudan Grass and Brome plus Blue Grass? (Hatch and Station Local)

Twenty-eight head of yearling grade Hereford heifers were used. Results of other years work with this will be summarized and a bulletin will be published.

Fattening Fall Pigs on South Dakota Grains. (Station Local)

Forty thrifty fall pigs were divided into five lots and fed comparatively shelled corn, good quality hullless barley, musty hullless barley (bin burned), good quality of hull barley and ground proso, each being supplemented with tankage, alfalfa hay, and a mineral mixture.

The differences in the rates of gains and the feed required for 100 pounds gain between the lots fed barley and corn were very slight. The ground proso did not prove as efficient as the ground barley.

Winter Rations for Brood Sows. (L. Stock Exp'l. Revolving)

Shelled corn and ground barley and ground oats were compared in winter rations for mature brood sows. Ground oats also were fed to two lots of bred gilts to obtain data on the comparative value of oats for growing gilts and mature sows, each being bred for spring pigs.

Tests in this line have been made during four winters. Data are being compiled in order to make a summary of the four years' work. It is evident that factors other than merely the kinds of feeds given the pregnant sow have considerable influence on the strength and vigor of the pigs.

Rations for Spring Pigs After Weaning. (L. Stock Exp'l. Revolving)

Different grain and forage crops will be "hogged off" with pigs after they are weaned and before corn is ready to pick, the object being

to determine the most suitable crops to provide early home-grown feed.

Six lots of three acres each have been seeded to different grain and forage crops. The pigs will be divided into uniform groups and turned in as soon as the grain has matured sufficiently.

To Eliminate Tail of Sheep by Breeding. (State Experiment)

Rams with no tails developed here through selection are mated with ewes of the same breeding. Conformation of body and quality of fleece are characteristics desirable in addition to the open face.

Lambs were born during May and June. On July 2 they were examined. There were 37 head. At this time selection was made for desirable characters. Tails of 15 of the 37 head were not cut off. The lengths of these tails varied all the way from no evidence of a tail to tails two inches long.

Value of Using Karakul Ram on Different Breeds and Grades of Ewes. (State Experiment)

Some progress was made. Several of the toothless, bad-bagged ewes were sold for mutton. A few of the hides from lambs were tanned and made into caps to determine their value in the market.

There is a wide variation in the quality of the pelts taken at birth from lambs of the same breeding, which tends to show that much work must be done to determine breeding power of the purebred Karakul. We are strongly of the opinion that a testing station for Karakul rams should be established to determine their breeding power.

This year's crop of lambs will be retained until they are 90 to 100 days old, with a view of getting pelts that will match some attractive pelts taken from lambs of a similar age one year ago.

The following co-operative experiments were conducted during the year

At the Government Station at Newell, (Special State Fund.)

RATIONS FOR LAMBS

Five hundred and forty-six range lambs were purchased and divided into 14 lots of 39 head each and fed on the following rations:

Lot 1—Dry pulp and alfalfa hay.

Lot 2—Dry pulp 5 parts, cottonseed cake 1 part, and alfalfa hay.

Lot 3—Barley and alfalfa hay.

Lot 4—Oats and alfalfa hay.

Lot 5—Corn and alfalfa hay.

Lot 6—Pressed pulp, cottonseed cake and alfalfa hay.

Lot 7—Pressed pulp and alfalfa hay.

Lot 8—Pressed pulp, molasses and alfalfa hay.

Lot 9—Pressed pulp 60 days, finish with barley, cottonseed cake and alfalfa hay.

Lot 10—Barley 5 parts, cottonseed cake 1 part and alfalfa hay.

Lot 11—Corn 5 parts, cottonseed cake 1 part and alfalfa hay.

Lot 12—Corn 5 parts, linseed meal 1 part and alfalfa hay.

Lot 13—Dry pulp $2\frac{1}{2}$ parts, barley $2\frac{1}{2}$ parts, cottonseed cake 1 part and alfalfa hay.

Lot 14—Dry pulp 5 parts, linseed meal 1 part, and alfalfa hay.

The object of this experiment is to get information on value of home-grown feeds for fattening lambs.

These lambs were fed in yards in the open and marketed in Sioux City, February 21, 1930.

These rations have been used for two years, some for three years and will be continued another year.

Cottonseed meal and linseed meal have about equal feeding values for lambs. The addition of cottonseed cake or linseed meal to a dry pulp ration decreases the cost of gain and produces a better finish. Dry pulp has about the same feeding value as barley when fed without a concentrate, and a somewhat higher feeding value when supplemented with cottonseed cake or linseed meal. Dry pulp made larger gains than pressed beet pulp, both with and without a supplement of cottonseed cake or linseed meal. In comparing the relative feeding values of corn, barley, dry and pressed pulp, when fed with a concentrate, the cottonseed cake and linseed meal have a much higher feeding value in the pulp rations than with either corn or barley. Pressed pulp can be used to advantage during the first half of the fattening period when supplemented with cottonseed cake or linseed meal and finished on barley and corn.

Chemistry Department Co-operating (Station Local)

By selecting breeding animals resistant or immune to the so-called "alkali disease" the object of this experiment is to develop a resistant or immune strain of hogs. Little progress has been made during the three years this work has been carried on. Not more than one-fourth of each litter farrowed has proved resistant to the trouble. Two resistant gilts and one resistant boar are now in the herd.

Because of the small number of pigs in each litter which prove immune or resistant, it is doubtful if an immune strain can be developed.

Influence of Direct Sunlight on the Development of Dairy Cattle (Hatch and Station Local) Influence of the Absence of Sunlight During the Growth and Development of Cows on Milk Subsequently Produced.

(Department of Dairy Husbandry Co-operating)

Three lots of pigs were fed on a basic-ration of white corn, wheat shorts, linseed oilmeal and a mineral mixture. In addition, Lot 1 was fed milk from cows developed in direct sunlight. Lot 2 was fed milk from cows developed away from direct sunlight, and Lot 3 was fed cod liver oil. This will be repeated the coming year.

Department of Pharmacy Co-operating Oil of Chenopodium (Purnell)

Twenty-seven pigs, grown supposedly under worm conditions, were divided into three lots. Lot 1 was not wormed. Lot 2 wormed once and Lot 3 wormed twice. The oil of chenopodium treatment was used. All three lots were fattened on the same grain ration. Slaughter tests showed pigs were not badly infested with worms. This is to be repeated the coming year.

CHEMISTRY

So-Called "Alkali Disease" (Purnell)

In the feeding experiments the albino rat was found to be a satisfactory experimental animal, as autopsies on over 60 rats have shown the same lesions as were found last year in the four hogs and the horse.

From the standpoint of food analysis no difference is found in the corn producing this trouble when compared to local corn.

Ordinary qualitative tests do not indicate unusual elements present in the ash of the "alkalied" corn.

Experimental work indicates that it is very improbable that this trouble is due to bacterial infection.

There are indications that the salt content of water may have a very decided influence on normal metabolism.

All possible efforts are being made to increase the work on this project because of the fundamental information that can be obtained for the nutrition of all stock.

How soybeans can be fed with corn to avoid soft pork. (Cooperative with Animal Husbandry.) (Purnell)

Twenty-three samples of each, fat back and leaf lard, were extracted and determinations of the refractive index, specific gravity, iodine number and melting point made from last year's feeding trials, and also on 30 samples from this year's feeding trials.

No correlations were obtained by the different physical and chemical determination.

Study of Kinds and Quality of Materials in Women's Coats from Typical Retail Stores of the State. (Cooperation with Home Economics) (Purnell)

Fifty-eight samples of coat material and coat linings representing materials from coats obtained last year and this year were analyzed.

The chemical analyses of the coat materials are accurate but those of the coat linings may be questioned in those cases where artificial silk was present due to the fact that our present methods of analyses are not standardized to take into consideration the different types of artificial silk used. The results were published in Experiment Station Bulletin No. 248.

The Use of the Combine Harvester (Cooperative with Agricultural Engineering Department.) (Purnell)

Forty-eight moisture determinations in duplicate on oats were made according to the procedure of the U. S. D. A., official grain standards. These results were published in Experiment Station Bulletin No. 251.

Comparative Metabolism of Several Calcareous Materials in Poultry Feeding. (Cooperative with the Poultry Division.)....(Hatch)

This experiment is being run to confirm last year's results. It has progressed through the twenty-fourth week of experimentation and will continue until all chickens are molting. So far this year's work has confirmed last year's results, that is:

- (a) That the lack of calcareous materials will cause a loss in the strength of egg shells.
- (b) It will decrease egg production.
- (c) The source of calcium influences egg production.
- (d) It also influences egg shell strength.
- (e) The results indicate again that animal sources of calcium such as oyster shells and clam shells are superior to other sources.

DAIRY HUSBANDRY

"A Comparison of Sweet Clover, Alfalfa and Sudan Grass Pastures Under South Dakota Conditions." (Purnell)

We have available for pasturing this year alfalfa and Sudan grass pastures. The sweet clover winter killed.

The cows were turned into the alfalfa lot on May 26 and on the Sudan grass pasture July 1.

Chemical analyses have been made of the milk of the cows on the pastures. If the cows are kept on the plats, at least one more chemical analysis will be made. Ten day composite milk samples are being taken for fat tests.

No cases of bloat have been observed, although the cows have been kept on the plats continuously except for the time required to milk them.

"Comparison of the Filter versus Clarifier for Market Milk." (Hatch)

Dan Jacobsen has taken over the work on this project. Much of the work has been repeated in order to verify data already obtained as well as to add to the total amount of data.

The work on this project seems to justify the following conclusions:

1. The clarifier is more efficient than the filter in removing foreign substances which have a greater specific gravity than milk.
2. The clarifier removes a greater quantity of substance than the filter.
3. Clarification increased the bacterial counts of the milk.
4. The time interval for reduction of methylene blue was less for the clarified milk.
5. The cost of operation considering initial cost, life of machine, and cleaning was less for the filter than the clarifier.
6. Filtered milk showed a somewhat better cream line than the clarified milk.

"Roughage Grinding" (Station Local)

This is a cooperative project and has been carried on with the animal husbandry and agricultural engineering departments.

The data from the work as carried on by the dairy husbandry department indicate the following conclusions:

1. Milk and fat production were increased slightly when the ground roughages were fed. The increase ranged from 2 to 5 per cent.
2. The increase in fat and milk production was not sufficient to offset the added costs due to grinding.
3. The coefficients of digestibility were not increased when ground roughages were fed. The digestibility of the ration is not increased by mixing the grain and ground roughage.

"Speltz vs. Corn; Speltz vs. Barley for Dairy Cows." (Station Local)

Three 40-day trials were conducted with seven cows in which speltz was compared with yellow dent corn, and a good grade of barley. The reversible method of feeding was used.

The cows were fed a ration of alfalfa hay, corn silage, oilmeal, bran, oats and either corn, barley or speltz. The ration was balanced according to the Morrison standards.

The cows were weighed on 10-day periods, and any changes in the ration which were deemed necessary were made at that time.

It is planned to repeat these trials at least once and if the resulting data is conflicting they may be run several times. The results of the one trial showed that speltz was equal to corn or barley for dairy cows. The speltz is not as palatable and we found it was necessary to take one cow off the trials because she refused to eat the ration which contained speltz.

**"Influence of Sunlight on the Growth and Health of Dairy Heifers."
(State Experiment)**

Four heifers have freshened and have been milking since September and December. Four of the heifers have been slaughtered.

Tests have been made on the breaking strength of the bones, which have also been chemically analyzed.

Chemical analyses have been made of the milk of those heifers which are in milk. The milk has also been fed to chickens and pigs, the results of which will be recorded under another project.

The following conclusions are deduced from the first part of this experiment:

1. Sunshine does not increase the weight or skeletal growth of heifers up to $2\frac{1}{2}$ years of age.
2. So far as physical appearances go the lack of sunshine does not affect the health of growing calves.
3. Chemical analyses for calcium and phosphorus in various bones indicated no significant difference in the bones of calves exposed to sunshine and those which were not.
4. The milk and fat production of the heifers not exposed to sunshine seem to be normal in quantity.

**"Effect of Milk from Cows Exposed to Sunshine vs. Milk From Cows Not Exposed, on the Growth and Development of pigs."
(Station Local)**

This project is being carried on in cooperation with the animal husbandry department.

One trial has been completed in which three lots of pigs were used. One lot received milk from cows exposed to sunshine and the second lot received milk from the no sunshine cows. The third lot received no milk but cod liver oil was added to the grain ration.

All lots received the same basic grain ration and mineral mixture. The grain ration and mineral mixture were fed ad libitum.

The pigs were weighed regularly. They were kept in pens on the north side of the hog house and not allowed access to sunshine at any time during the trials.

Conclusions:

1. The two lots of pigs receiving milk grew faster at first and made better gains than the cod liver oil lot.
2. In five to six weeks the two lots of pigs which were receiving milk showed symptoms of rickets. They were tender on their feet and walked with a stilted gait.

3. The condition of the pigs at the close of the trials indicated that there was somewhat more anti-rachitic value in the milk from cows exposed to sunlight than the milk from cows not so exposed.
4. Eight pounds of whole milk fed daily was not equivalent in its vitamin D potency to feed containing 1 per cent cod liver oil.

"Cross Breeding Experiment." (State Experiment)

Eight heifers have freshened. One has completed two lactations and is well along in the third.

Several F2 calves have been dropped. Only one of these is a female. This one is being retained in the herd.

The per cent of fat of the F1 is about the average of the two breeds. So also is the birth weight of the calves.

The F2 are red and white in color from a black and white sire and dam.

HOME ECONOMICS

Home Management Project (Purnell)

"The Use of Time by Rural Homemakers of South Dakota," has been closed and the results of the study published in bulletin form.

This study was in the nature of a survey and was started in the autumn of 1927. It was in co-operation with the Federal Bureau of Home Economics, United States Department of Agriculture. All blanks and general directions for keeping and tabulating the records were provided by the federal bureau.

The homemakers aiding in this study kept a complete record of their time (24 hours per day) for seven consecutive days.

More than 400 blanks were sent out, and of these about one-third were returned. A few were inaccurate, some were returned incomplete. Finally this summary was made of the 100 records that seemed best to typify rural conditions in the state.

Thirty-eight of the 69 counties of the state are represented in the summary.

Of the 100 records used, 17 were kept during the summer, 14 during the fall, 22 during the winter and 47 during the spring. The greatest number of records in single months were 24 in April and 16 in May.

There are five general divisions of time made, namely: homemaking activities, farm work, other work, personal activities and miscellaneous.

A summary of a few of the facts brought out by the study follows:

1. The records show an average working week of 66 hours and ten minutes for the homemaker. This is higher than other states that have conducted the same survey, have found it to be. The average of some 700 records the Federal Bureau of Home Economics gives 63 and a half hours as the working week. Washington gives its average as 63 hours, Oregon a trifle under 64 and Nebraska a trifle over 64 hours.
2. The average amount of time devoted to homemaking is 54 hours and 13 minutes per week. Season has no influence on the amount of time spent in this activity.

3. Nearly 50 per cent of the time devoted to homemaking is spent in providing food for the family.
4. Average amount of time spent in farm work is 11 hours and 15 minutes. Homemakers give nearly 75 per cent more time during the spring and summer than in the fall and winter.
5. The rural homemaker averages eight hours and 36 minutes in sleep each night.
6. The homemaker's leisure amounts to a little more than three hours each day.
7. Fifty-nine of the records show the farm to be run by the owners, 41 of the farms are rented.
8. Bread baking is one of the activities that is being taken out of the home. The reports show that 49 women bake all of their bread, 23 buy part and bake part, twenty buy all of their bread and eight did not report on this point.
9. Of the 100 women all but one reports some time spent in some type of farm work.
10. Thirty-three women record time spent in the care of livestock with an average of a little less than two hours per week.
11. Ten women report field work with an average of a trifle over two hours per week.
12. Forty women report time spent in gardening with an average of three hours and five minutes per week.
13. Eighty-three women averaged five hours and 40 minutes spent with poultry.
14. Eighty-three women report an average of four hours and 58 minutes in dairy work. A few of these women help with the milking, but a major part of the time charged to dairy work is being used in washing the separator and milk pails.
15. Two women report work outside the home for compensation. One gives four music lessons per week; the other helped a neighbor with sewing.

The results of this study are out in bulletin form.

Nutrition (Purnell)

This included a study of the Vitamin C content of Swiss chard and spinach both fresh and cooked in the open kettle as cooked by the housewife, and of commercial canned asparagus, green and white tip and juice from each.

The spinach and Swiss chard used were fresh each day.

Sherman's basal ration was used.

Both vegetables were cooked in an open kettle with a small amount of water for about 15 minutes. It depended somewhat as to the condition of the spinach and chard. There was a while in the summer when the spinach especially, seemed rather tough and required more than 15 minutes cooking. No effort was made to evaporate all the moisture. It was used as it would be served. However, we tried to control the moisture by using a small amount in the first place.

In feeding the raw Swiss chard to guinea pigs the leafy portion and the white rib were separated. Two groups were fed 2 grams and 4 grams of the green leaf respectively, and two groups were fed 2 grams and 4 grams of the white rib. The ones fed on the white rib were always very anxious for their portions, and ate them immediately. Those on the green portion of the leaf were always slow about eating theirs. Two or three often would not eat theirs in all day. Yet on the whole those on the green leafy portion seemed to make better gains, and show fewer indications of scurvy than did those on the white rib. The ash content of the green leaf and white rib was determined separately by the experiment station, chemist.

	Green Leaf	White Stem and Rib
Moisture	86.56%	91.37%
Ash	2.32%	1.37%
Organic Matter	11.12%	7.26%

The results indicate that 1 gram of raw spinach is sufficient to protect a guinea pig from scurvy over a period of 90 days and that Swiss chard is very low in Vitamin C content.

The white and green asparagus (commercial canned) were found to be as rich in Vitamin C as commercial canned spinach. There seems to be no difference between the white and green, in the Vitamin C content.

The juice of either is practically as rich in Vitamin C as the stalk.

Clothing (Purnell)

A Study of Womens Coats

Sixty-six garments have been studied. The coats were purchased from typical retail stores in the state. The places where the garments were bought are: Aberdeen, Brookings, Deadwood, Huron, Madison, Mitchell, Rapid City, Redfield, Sioux Falls, Vermillion and Watertown.

The following tests were made:

1. Weight per square yard
2. Weave
3. Number of picks and ends
4. Yarn count
5. Yarn twist
6. Length of staple
7. Microscopic study
8. Chemical analysis
9. Tensile strength for woven and bursting strength for knit fabrics
10. Weathering
11. Abrasion under Kertez method
12. Abrasion under tensils strength
13. Water proofing
14. Fastness of color
15. Shrinkage

Conclusion—The number of coats examined is too small to draw general conclusions but some may be made for the group. The high priced garments tested higher on the average in every case except in

some of the tests for fastness of color. The percentage of advantage was small in proportion to the increase in price. Many of the high priced coats tested low in one or more properties. The results of this study are out in bulletin form.

ENTOMOLOGY

The Plum Tree Borer (Adams)

The plum tree borer (*Synanthedon pictipes* G and R), its distribution, life history, economic importance and control.

The work on this project is drawing to a close. During the past year, additional information was obtained regarding the distribution, life cycle and habits of this pest.

In our last two reports we discussed the preparation and application of a remedy for the borers. This remedy consisted of a mixture of paraffine and paradichlorobenzine. We also reported upon the practicality of using this remedy and the efficiency of it. Trees treated with this material and kept under observation during the past year have again demonstrated the value of this compound as an efficient control measure. To date we have not discovered any injury caused by this treatment to either young or old treated plum trees.

Some attention was devoted this year to experimenting with vehicles other than paraffine as a carrier of the paradichlorobenzine. This was done with the idea of finding a fluid carrier which would remain liquid without the use of heat. A carrier of this kind would mean a great saving in heat and labor and possibly a saving in expense. Several materials have been found that promise to be useful, but further experiments must be carried on before definite conclusions can be drawn.

Many of the illustrations which will be used in illustrating the published bulletin of this project have been prepared during the past year, and others are being prepared. The next fiscal year should bring about the completion of this project.

The Crytanthacrine Grasshoppers (Adams) The grasshoppers of the subfamily, Crytanthacrinae, of South Dakota, their economic importance, distribution, life histories and control.

During the past year an additional 1,500 specimens of Crytanthacrine grasshoppers were collected in the state. We now have approximately 15,000 specimens of these grasshoppers in our collections. They are all properly pinned, labeled with locality and collectors labels, and stored in Comstock cases. The collection represents 36 species of hoppers. All the material is classified and all the specimens representing a single species or variety are stored together in one or more Comstock cases. A map of South Dakota has been prepared for each species of hopper, showing the distribution of that hopper over the state. Notes concerning its economic importance are also included.

During the past year, one additional species of grasshopper not heretofore recorded was found in southeastern South Dakota. This species, *Melanoplus punctulatus* (Scudder), is not included in the list of South Dakota Crytanthacrine grasshoppers published in the 1927 Annual Report of the Director of the South Dakota Experiment Station.

During the past year the grasshoppers of the state showed a decided increase in numbers. However, of the 36 species under investigation, only four promised to become excessively abundant. These four species, *Melanoplus femur-rubrum femur-rubrum* (DeG.), *Melanoplus differentialis* (Thos.), *Melanoplus bivittatus* (Say), and *Melanoplus mexicanus mexicanus* (sauss.) have not been our most destructive hoppers during the past 25 years. From experiments which we conducted during the past year, it was found that the number of egg masses laid by these grasshoppers is not limited through heredity, but is dependent largely upon the prevailing temperature. A temperature of 75 degrees F. or more favors egg production and egg laying, while a lower temperature does not. Consequently, if, during the summer, the temperature ranges above 75° for a large portion of the time, the number of egg masses laid per grasshopper will be more numerous than if the temperature were lower.

Dry weather has been found to favor grasshopper outbreaks, while a high relative humidity tends to reduce outbreaks of these insects. A high relative humidity combined with a favorable temperature encourages the rapid growth and dissemination of a deadly fungus disease among the grasshoppers, and at the same time prolongs the adult life of parasitic flies. By prolonging the adult life of the parasitic flies, more grasshoppers will become parasitized with fly maggots. While flies are not the only parasites of grasshoppers, year in and year out they are undoubtedly the most important biological checks that we have in South Dakota.

Pollinating Agents of Sweet Clover (Adams) A study of the pollinating agents of sweet clover in South Dakota with special emphasis upon seed production as influenced by the honey bee.

Much of the time that was devoted to this project was consumed in identifying a portion of the collection of insects that was made during the year July 1, 1928 to June 30, 1929. This collection, consisting of approximately 10,000 mounted and labeled insects was made by sweeping the blossoms of white and yellow sweet clover with an insect net. The identification work is a rather slow and tedious process, but all of the bees and most of the flies have been identified.

A large number of growers of sweet clover in South Dakota were visited with the purpose of learning the amount of seed that was produced per acre by each grower during the past year. These data were later to be correlated, if possible, with the distance that the fields were removed from apiaries. The number of hives in the apiary was a factor that was also to be considered.

It had been planned to compare the seed yield from two fields of sweet clover or two groups of fields of sweet clover that were growing under as nearly identical conditions as possible. These conditions included not only climatic and soil factors, but also management. To one field or group of fields, honey bees should have access, while no honey bees were to have visited the other field or fields. In a similar way, the number of hives necessary for producing a satisfactory pollination of an acre of sweet clover was to be determined. It was also

planned to gather data that would prove or disprove the idea that the seed yield of a field of sweet clover is directly proportioned to the proximity of three hives per acre of clover. A large amount of data relating to these problems was accumulated during the past year.

FARM ECONOMICS

Studies in Agricultural Finance (Purnell)

In the field of agricultural finance a general study of the credit agencies serving South Dakota agriculture, of the cost of credit to farmers, and of the possibilities of betterment was begun about four years ago. A considerable quantity of statistical data concerning this has been assembled, and credit changes occurring on a considerable number of farms in representative counties have been studied. The collection of information on the farm real estate situation was pursued during the current year. The purpose was to learn the total amount of indebtedness, both for the township and on a per acre basis for the land mortgaged, and the changes in indebtedness over a period of years. The source of funds, cost, the terms and the duration of the loans at different periods are also to be determined. Special consideration has been given to a study of the effect of land sales on indebtedness. It is hoped to show the long term credit needs of farmers, how these have been met, and what changes may be desirable.

Progress made includes preliminary tabulations or abstracts of the mortgage data for the counties of Brookings, Clark, Haakon, Turner and Hyde. The Brookings county material has now been published in mimeographed form. Considerable delay was occasioned by a late decision to include a study of the effect of sales on indebtedness. This incurred the procuring of additional sales data from the county records, and considerable time was required for organizing and analyzing this material. The Brookings county data for the three townships show an increase in indebtedness from \$731,537 in 1910 to \$2,702,565 in 1920 and \$2,359,387 in 1927. This is a 369 per cent increase from 1910 to 1920. The area subject to mortgage rose from 50.84 per cent to 65.56 per cent of the total during the same time, but declined slightly after 1920. There has been a considerable shift in the source of loans from individuals to insurance companies. Most of the loans were made at somewhat more than six per cent. The most customary term for which loans were made was five years. Lands which had been sold had increased more in indebtedness than lands not sold, but other factors besides sales had contributed to the increase of indebtedness.

Study of the Combine Harvester (Purnell)

The purpose of this study was to provide information concerning the cost and practicability of the combine harvester for use under South Dakota conditions. The work on this project was completed last year, and is reported in Experiment Station Bulletin 244, dated September, 1929, and entitled "The use of the Combine in South Dakota." This project was a joint undertaking with the college agronomy department. In this study combined grain is compared as to costs, quality and price, with grain harvested with binders or headers and threshed with stationary separators.

Results of the study showed the combined grain to be more variable than binder-cut grain in moisture content, and its average moisture content higher. The cause of this wider range is attributed to excessive moisture in grain combined early in the season, early in the morning, and too soon after rains. The other extreme, that of very dry combined grain, was the result of a short period of excessively hot and dry weather. The price differentials for the various moisture percentages during August, 1928, were such that there were slight losses from marketing wheat with moisture contents both above 14 per cent and below 13 per cent. However, the losses per bushel on the wet grain were not as great as the price discounts because the latter did not fully offset the weight of the moisture. Likewise the premium for extra dryness was not sufficient to compensate for the weight loss through evaporation below the 13 per cent moisture content. Thus, there was a small loss in price, both on the extra dry and the extra wet combined grain, but this loss was not enough to wipe out the gain from lower costs of harvesting with the combine.

Studies in Farm and Ranch Management (Purnell)

The work in farm management is concerned with the study of the management of individual farm units, with a view of determining to what extent and in what ways profit might be increased in the various type-of-farming areas in South Dakota. The study entitled "Types of Farming in South Dakota," (Reported in Station Bulletin 238, June 1929), differentiated 13 type-of-farming areas and pointed out the underlying reasons for the systems of farming now being followed and outlined suggested systems typical of each area.

Three of these 13 areas have now been studied in detail. Two of these, namely, the East Central area, reported in Bulletin 226, and the Intensive Spring Wheat area reported in Bulletin 235, were reviewed in the annual report for the year ending June 30, 1928. The third, the Southeastern Corn Belt was reviewed in part in the annual report for the year ending June 30, 1929. This project somewhat similar to the earlier studies, had for its purpose the determination of the production requirements for crops and livestock as handled by typical farms of this intensive corn and hog producing area, with a view of setting up standards and farming systems which would be useful to individual farmers in planning better farm organization; useful in showing a method whereby annual outlook and other economic information may be applied to specific farm systems; and useful to extension workers and other teachers, in that specific examples of farm reorganization are given for farms of the most typical sizes in the area.

This study has now been reported in Station Bulletin 249, dated March 1930. It was found that increased returns are possible on many of the farms in the area studied through the establishment of systematic crop rotations, improvement of the soil, addition of livestock to utilize the crops produced, better feeding and sanitation practices, and production to meet market demands.

The study of a fourth area which is rapidly changing from extensive small grain farming to general farming, and of which Potter county is typical, was started January, 1930. This will deal with the various

farm organizations common to the area, the variations in standards of size and combinations of enterprises, and the standards of accomplishments which prevail under varying conditions. The work this year departs from the past in that some of the detail records commonly secured are dispensed with, and instead three times the usual number of farms are being studied.

The ranch management project has covered a three-year period and had to do with the organization and operation of 60 cattle ranches, 15 located in each of the four states—northwestern South Dakota, southwestern North Dakota, southeastern Montana and northeastern Wyoming. This project has been a joint undertaking between the agricultural economics and animal husbandry sections of these four states and the bureaus of Agricultural Economics and Animal Industry of the United States Department of Agriculture.

The purpose of the study in this state has been to determine the most efficient methods of livestock and crop production used by ranchers on the various sized ranches in northwestern South Dakota. The problems involved have had to do largely with the production of home grown feeds, land tenure, increasing of the size of the calf crop, time of selling, etc. The field work was completed last year. The United States Department of Agriculture will publish a technical bulletin covering the entire area, and South Dakota is publishing a bulletin covering the study from the standpoint of this state. The South Dakota bulletin is ready for publication when approved by the cooperating bureaus at Washington.

The study indicates that the most successful ranchmen have business organizations which are quite efficient and which can be used as examples for other ranchmen to follow. The published bulletin should be an aid to ranchmen, and the basis for effective extension work.

Study in Marketing (Purnell)

In the field of marketing, the first study undertaken has been that of the management, financing, and organization of farmers' elevators in the spring wheat area, with a view of finding possibilities of bettering their organization, lowering their costs, and improving their services. The first phase, which deals with a historical study of farmers' elevators, traces the development of business and organization practices of about 15 widely scattered, representative spring wheat elevators beginning with the 1919 crop. Considerable historical data have been tabulated during the past year. This phase is being carried on independently by this station.

The second phase, treating with a detailed study of current operating practices of farmers' elevators, concerns current data and is especially broad in that it covers practically all aspects of the business. This phase is being pursued in cooperation with the Division of Cooperation at Washington, with which division three other states, Minnesota, North Dakota and Montana are cooperating in a spring wheat area study. These three states completed their fifth and last year

with the 1929-30 station fiscal year, at which time the South Dakota station completed its third and last year collecting data. During the year 22 elevators were visited from which the following information was obtained: data on the economic set-up as it affected costs of operation and stability of the enterprise, considering such factors as the size of business units, the amount of labor, size of plant, amount of supplies, etc., required for economical operation; relation of volume of business, completeness of hedging practices, seasonability, transportation facilities, etc., to efficiency of operation; the relation of the management to the board of directors and to other employees; and the sources of capital and problems involved in the different methods of financing.

The material is now in process of summarization and analysis. It is hoped that both the Division of Cooperation at Washington and the College Station may each be able to publish a bulletin during the next fiscal year. The tabulations this year seem to substantiate the conclusions previously drawn, that it seems advantageous in many cases to increase volume of business by sideline operations, and that economies result in the local conditioning and cleaning of grain; also that low grain handling costs appear between 200 and 400 thousand-bushel volume, and that sidelines are too often handled merely as an accommodation to grain growers instead of for profit to the business.

Studies in Prices and Statistics (Purnell)

Gathering and organizing of all available material concerning prices received by South Dakota farmers in years past is recognized as being fundamental to many studies, such as costs of marketing problems, transportation problems, factors affecting prices, etc. The purpose of the present price study is to establish a series of historical prices and to determine the principal factors affecting prices and production of agricultural products in South Dakota.

Practically all of the historical price data available have been collected by a thorough canvass of all likely sources. A study of factors affecting the price and acreage of flax, which will attempt to bring together all available information on this subject, was begun in September, 1927. Later it seemed advisable first to complete the work of tabulating and summarizing the price data on all commodities. This phase of the project is now nearing completion. The estimates of prices will be published at an early date. These prices cover the principal agricultural products of South Dakota by months and are comparable to the farm prices published by the United States Bureau of Agricultural Economics. The addition of this to the data now available will furnish a complete series from 1890 to date. It is planned to make the results of the study on flax prices and production, and prices of other commodities available during the coming year.

Bulletins on this project already published consist of Bulletin 225, "South Dakota Farm Production and Prices," which brought together basic data on prices and production back to 1890, and Bulletin 233, "South Dakota Potatoes, Production, Movement and Prices."

Studies in Public Relations (Purnell)

Two studies have been undertaken in the field of public relations. The first of these, consisting of a study of the taxation problems of agriculture in South Dakota has been completed and the results published in Bulletin 232, "Taxation and Public Finance in South Dakota." The second study in this field was started in August, 1928, and has to do with the relation of transportation rates and facilities to farm prices and types of farming. The purposes of the two phases of this project carried on during the year are: First, to study the incidence of transportation rate changes on certain agricultural products in an attempt to measure the direct effects, in terms of price changes in producing areas and in the central markets; the more important indirect changes, and the net effect on producers' incomes of the resultant shifts to less remunerative uses of the productive factors. This recognizes that changes in freight rates alter the comparative advantages of different areas for the production of a given product. Second, to conduct a general investigation of the economic problems and economic effects of the development and use of motor truck transportation.

Most of the theoretical analysis of the first phase has now been worked out and written up. This includes an analysis of the nature of the changes brought about by freight rate changes, an analysis of the supply phase of the problem, and of the demand relationships as affected by distances between different parts of a large market. Work has been started on the collection of data on prices, rates, and production of potatoes by areas and markets, and the analysis of these data. Some work has been done along the line of simplification of the findings in terms of governmental policy relative to railroad rates.

With regard to the second phase, most of the material from the western part of the state has now been secured. Analysis is under way of trade territories in selected areas, of rate changes, of amount of commercial trucking done as compared with all trucking, and of the average distance hauled as compared with hauling by farmers themselves. The data collected include information on earnings and average life of trucks together with data on the truck companies themselves.

HORTICULTURE

Fruit Breeding (Adams)

This department does not conduct a commercial nursery, but propagates and distributes new varieties originated in the department or imported from similar climates of the old world. In the work of originating new fruits more than 600,000 seedlings have been grown the past 34 years. The improvement in size and quality each plant generation is greater year by year. Hybridization and selection are the main methods of improvement. The number of fruit seedlings steadily increases and selections are being made each year for propagation and distribution. The following were offered for the first time in 1930, and plants were distributed.

Siberian Dewberry—While sailing up the Irtysh River in Tomsk province, Siberia, in 1908, Dr. N. E. Hansen noted with interest the many painfuls of native dewberries brought to the steamer landings by the peasants. The fruit is roundish, small, black, with bluish bloom. Un-

der cultivation on the open prairies here at Brookings the fruit, while of clear acid quality, has been too small to introduce as a market fruit. However, it may do better farther north. It is worthy of attention as the fruit can no doubt be increased in size by selection. The plant is hardy and productive. This is seed and Plant Introduction No. 24377.

Elk River Wild Crab: A Dwarf Ornamental Lawn Tree—Seedlings of *Pyrus Ioensis* from Elk River, about 40 miles north of Minneapolis, on the Mississippi river. Originally found by A. W. Keays. This makes a larger tree than the Nevis wild crab, but begins to bloom very early. The beautiful pink flowers are decidedly ornamental.

Nevis Wild Crab: A Dwarf Ornamental Lawn Tree—The wild American crabapple, *Pyrus Ioensis*, from the farthest northwestern point where it has been found native, Nevis, Minnesota, near the headwaters of the Mississippi river. Originally found by James Arrowood. A beautiful ornamental tree bearing when only four feet high with rich pink flowers in great profusion.

Alika Rose—Obtained by N. E. Hansen in Russia in the fall of 1896. Described in Bulletin 240. The name is adapted from the botanical name *Rosa gallica grandiflora*. Flowers large, fragrant, semi-double, with as high as 47 petals, with many stamens. Color brilliant red with no purple, mauve or violet-red in it. It gets far away from the mauve pink of most of our wild prairie roses.

Earlier Introductions

Plants of the following earlier introductions were also distributed the past year: Redflesh crabapple, Ming pear, *Pyrus Ovoidea* pear, Siberian perennial sweet pea, seedlings of the Siberian honeysuckle from Semipalatinsk, Siberia), cuttings of 32 varieties of grapes (introduced in 1925), plants of the new State college roses described in Bulletin 240. In plums and sandcherry hybrids, the following were distributed: Sioux sandcherry, Hansen Select sandcherries, Sanoba sandcherry, and the Etopa, Tawena, Opta, Sapa, Wachampa, Cistena, Ezaptan, Cheresoto, Sansota and Okiva plums.

Progress With Pears

The seedling pears grown from seed obtained from fresh fruit a few miles east of Harbin, North Manchuria, in 1924, and described in South Dakota Bulletin 224, have made good growth. The spring of 1930 35 acres were planted with these Harbin pears. This land is an addition to the State Orchard at Watertown, and is furnished free by Codington county. This orchard it is hoped will be a source of fruit from which to raise seedlings to furnish hardy pear stocks for the new hybrids coming on. It will also serve as material for improvement by selection of the pure *Pyrus Ussuriensis*. This is of special importance since the seed was obtained from the farthest northwestern limit of the species. The orchard will also serve as a place where hybridization with the large, choice quality pears of western Europe can be done on a large scale.

Genetics of Hardy Thornless Rose Stocks (Purnell)

In July, 1929, work was begun on the development of thornless hardy rose stocks under the Purnell fund. This matter is of special importance at this time since the federal government has announced

the early prohibiting of all rose stock importations. Thousands of flowers were hybridized, and many selections made from a large number of seedlings already on hand.

Bulletins

A report on the variety test of trees and shrubs which was carried on for many years on the Hatch fund was prepared for publication. Bulletin 246, "The Shade, Windbreak and Timber Trees of South Dakota," 48 pages, with five cuts, is being published this fiscal year. The remaining material on ornamental trees and shrubs is also complete and will be published as soon as possible with the available printing fund. The deductions made from this extensive test will be published in the third bulletin of this series. It will be a study of hardness.

The Marshall P. Wilder Silver Medal

At the winter meeting of the American Pomological society, the Marshall P. Wilder silver medal was awarded to Dr. Hansen for work in originating new fruits. This work was begun when Dr. Hansen first became horticulturist at this station in the fall of 1895.

Modifying the Germ Cells

Dr. Hansen this summer made a special study of the latest discoveries in modifications of the germ cells of plants, not only by hybridization but by special methods which have come to light in recent years, such as X-ray, radium, cold, methods of propagation, and increase in number of chromosomes as in polyploidy. The result of the study is expected to have a bearing on the future development of horticulture and agriculture.

Dr. Hansen's European tour in the summer of 1930 included attendance at the International Horticultural Congress at London, August 7 to 15, and the International Botanical Congress at Cambridge, England, August 16 to 23; also visits to experiment stations and to leading plant-breeding establishments, originators of new fruits, vegetables and flowers, etc. A study of type specimens was made at the Kew Gardens, London.

The American part of the tour included visits to the Carnegie Station for Experimental Evolution, Cold Spring Harbor, Long Island, New York; the Boyce-Thompson Institute for Plant Research, Yonkers, New York; the Arnold arboretum of Harvard university, Boston; the National Canadian herbarium, Ottawa, Canada; and the New York experiment station, Geneva.

PHARMACY

A Study of the Properties of Oil of *Chenopodium* obtained by Cross Fertilization as well as the Anthelmintic Value of this Oil. (Purnell)

Approximately 1,500 chenopodium plants were grown during last year. Oil having a high levo reading was obtained by steam distillation. This oil was used in the experiment. Purebred Poland-China pigs farrowed on the college farm were used in the tests. Because these pigs were not badly infested with worms, no definite results can be announced. Living ascarides were used in test tube experiments and much valuable information obtained. This year pigs were obtained from a farmer living near Brookings.

By actual test (Benbrook Method) these pigs were found to be heavily infested with worms.

Three more lots of pigs will be used this year than last year. Interesting and valuable results should be obtained. All this work will be carried on as in the past two years, with the cooperation of the animal husbandry department.

POULTRY

Comparison of High Protein Feeds (Purnell)

An experiment was conducted during 1929-30 with regard to feeding various high protein feeds to pens of laying hens, consisting of various breeds.

Pen No. 1 was fed the regular station ration and used as a check pen. Pen No. 2 received soybean meal plus the basal ration. Pen No. 3 received dried buttermilk powder. Pen No. 4 received buttermilk powder plus tankage. Pen No. 5 received alfalfa meal.

Pen No. 4, receiving buttermilk and tankage, produced the largest number of eggs. Pen No. 5, receiving alfalfa meal as a protein supplement, was second highest, followed by Pen No. 3, receiving the dried buttermilk. Pen No. 2, receiving soybean meal, produced slightly more eggs than the check pen. The same scratch feed ration was fed to each pen.

Pen Heating

This experiment was conducted by a senior student, using regular poultry equipment. No special fund was provided for this work.

Two pens of laying hens were used. One pen was heated to the extent that the temperature was kept above freezing at all times. In the other pen, no heat was provided.

The pen receiving heat consumed less feed and produced more eggs. When the combined cost of fuel and feed was deducted from the sale of the eggs, a balance of \$3.54 over production cost was shown in favor of the heated pen. If the factor of labor in attending to the heating unit had been considered it probably would not have proved profitable over the unheated pen.

Calcium Carbonate Carriers for Egg Shell Formation. (Hatch)

Two pens of Leghorns were used in this experiment. Pen No. 1 was fed oyster shells. Pen No. 2 was given the limestone sold under the commercial name of "Golden West Shell Maker."

Pen No. 1 consumed a total of 133 lbs. of oyster shells in six months and produced a total of 4,053 eggs. Pen No. 2 consumed a total of 106 lbs. of Golden West Shell Maker limestone in six months and produced a total of 3,952 eggs.

RURAL SOCIOLOGY

Purnell

During the past year ending June 30, 1930 W. F. Kumlien has completed the project on the "High School Education of Farm Boys and Girls in South Dakota." The results were embodied in bulletin 250 of the South Dakota Experiment Station published during March of the past year. In addition to this the field work has also been com-

pleted for sub-project number 3 dealing with the "Rural Health Problem in South Dakota." The results of this study will be published some time during the next fiscal year.

A digest of the conclusions of the high school study is as follows:

1. With few exceptions, the existing high school facilities of Brookings county and eastern South Dakota are either adequate or else are being rapidly expanded to take care of all the farm pupils who desire to obtain a high school education.

2. The high schools are relatively well distributed over the eastern portion of the state. It is estimated that approximately 80 per cent of the rural territory lies within a 7 mile radius of a high school. Probably one-half the main roads leading into the small towns are either gravelled or will be within the next two years. Probably half the farm boys and girls attending high school drive back and forth daily from their homes.

3. Slightly more than half of the farm children of high school age in South Dakota are now enrolled in high school. This is surprisingly high and compares favorably with town children.

4. The high school tuition charges to rural non-resident pupils in South Dakota averages \$12.29 per month. This rate is not excessive measured in terms of actual pupil cost, and is probably as cheap, if not cheaper at present to the rural districts than if their lands were included in the district maintaining the high school. This will not continue to be the case, however, when the number of farm children attending high school approaches 65 per cent.

Despite the fact that the high school tuition charge is paid by the pupil's home district, it places a heavy burden on the pupil's family. In addition to paying their share of direct school tax in the district, the family must defray the pupil's transportation cost and living expenses when away from home. It is probable that the time is now favorable for some form of state tax to aid high schools, which will relieve in part the expense of tuition costs to non-residents and reduce to some extent the local school tax to residents.

5. It is estimated that fewer than one-third of the general run of farm children attending high school return to the farm after finishing their high school course. The students taking vocational agriculture however make a much better showing, averaging between 60 and 70 per cent.

6. Everything considered, the farmers of eastern South Dakota have most to gain by not attempting to build up a separate rural high school system, but by continuing to patronize the high school already established, mainly in the villages, towns, and cities, of their respective communities.

The evidence when carefully considered from all angles seems to favor the consolidated or union type of high school for rural communities, especially when the elementary grades can be included in the system. However such general prejudice exists among farmers against consolidation as to preclude any rapid expansion of that type of school in the state at least for the present. The next best alternative for the farmers seems to be patronizing the independent high school which comprise 71 per cent of all the high schools of the state.

7. From the standpoint of the farmer the outstanding disadvantage of the independent high school system is the fact that he is a non-participant in the active management of the high school. As a paying guest he has little to say as to the kind and quality of service offered. While theoretically he does not have to patronize a given school, practically he has little choice. With few exceptions high transportation costs bind his children to the nearest high school.

8. Educational authorities differ as to the minimum sized rural high school, that, can advantageously offer courses in vocational agriculture and home economics. Professor Kumlien believes that the need for such courses is so vital to rural life in the state as to warrant special consideration from even relatively small high schools which serve rural communities.

High schools having as low an enrollment as 75 pupils can usually find a steady supply of at least 10 farm boys who are interested in agriculture. The modal average of enrollment of the 27 high schools in South Dakota offering Smith-Hughes agriculture for 1928 was between 50 and 75 pupils. The average number of farm boys taking the Smith-Hughes course in this group of high schools averaged 11.4.

It is often practical in the smaller schools to have the superintendent act as the agriculture teacher. In this way he can alternate the first and second year agriculture, thus devoting one-half of each day to that subject, and the remaining time to other teaching or supervising work. A number of schools in the state are following such a program.

VETERINARY

Hemorrhagic Septicemia (Adams)

The Adams fund project known as "Hemorrhagic Septicemia Project Number 1," that has been in progress for several years, has been continued in the past year along the same lines as previously reported. This project consists of a detailed microscopic, bacteriologic and pathogenic study of the various strains of hemorrhagic septicemia organisms that are isolated from material presented for diagnostic purposes from time to time.

The object of this project is to determine, if possible, a simple and accurate means of determining the pathogenic properties of hemorrhagic septicemia organisms without recourse to animal inoculations. The value of such information is great enough to justify the study since it is a well-known fact that hemorrhagic septicemia organisms recovered from animal blood and other tissues from time to time do not possess sufficient virulence to cause disease. They enter the general circulation of the animal after its vitality has been reduced from other cause, and unless extreme care is taken in making a microscopic diagnosis, the conclusion may easily be reached that hemorrhagic septicemia was present, whereas such was not really the case.

The study consists of the isolation of the organisms studied and reaction to at least 12 of the various sugars and their pathogenic properties when inoculated into rabbits and mice. Progress during the past year has been slow because hemorrhagic septicemia in farm animals

appeared to be less prevalent last year than in some of the previous years. No report can be formulated at the present time because it is felt that the work should be continued at least another year in order to secure a larger volume of data upon which to base conclusions.

Purnell Fund

The veterinary department is making use of Purnell fund for research purposes, but no definite project has been allotted to this department. Doctor Taylor, a member of the veterinary staff, assists various other departments in their work that involves a study of animal disease processes. During the past year Doctor Taylor has given assistance to the chemistry department in the study of alkali disease. He has given a considerable part of his time to a study of the lesions found in the bones of guinea pigs that are being used to test the vitamin contents of various canned foods.

He has also made post mortem examinations of fowls submitted by the poultry department, which fowls were employed for various research projects. He has likewise made several trips to the packing plant in Sioux Falls to assist in post mortem examinations of swine that were on soft pork experiments, and others that were on experiments involving the use of South Dakota grown worm seed as a means of expelling common round worms. None of these projects will be reported on completely by the veterinary department. In all cases, the results of the work performed in this department are submitted to the other departments in charge of the projects.

FINANCIAL REPORT
SOUTH DAKOTA AGRICULTURAL EXPERIMENT STATION
For Year Ended June 30, 1930

Receipts

Received from the Treasurer of the United States	Hatch \$15,000.00	Adams \$15,000.00	Purnell \$60,000.00
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Disbursements

By Salaries	\$ 8,248.27	\$ 7,141.58	\$29,672.22
Labor	3,228.21	5,263.42	12,795.05
Stationery and Office Supplies	20.27	70.58	565.83
Scientific Supplies, Consumable	175.96	457.04	806.53
Feeding Stuffs	304.53		2,074.41
Sundry Supplies	100.46	116.53	1,055.38
Fertilizers	1.50	35.81	
Communication Service	30.63	6.55	132.84
Publication	2,530.97		3,881.40
Travel Expenses		812.05	2,411.04
Transportation of things		32.09	128.19
Heat, Light, Water, and Power	13.55		58.68
Furniture, furnishings, fixtures	.83	152.90	986.22
Library	7.74	60.63	79.08
Scientific Equipment	262.50		2,246.46
Livestock		330.55	230.50
Tools, Machinery, and Appliances		130.50	2,079.33
Buildings and Land		389.77	796.84
Contingent Expenses			
Total	\$15,000.00	\$15,000.00	\$60,000.00

HORTICULTURE AND LIVESTOCK EXPERIMENT FUND

Appropriation	\$16,822.00
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Expended

Salaries	\$ 7,003.21
Labor	4,041.39
Feeding Stuff	1,460.68
Office Supplies and Stationery	44.39
Sundry Supplies	875.69
Traveling Expense	1,124.07
Transportation of things	137.10
Furniture and Fixtures	22.75
Livestock	1,826.00
Building and Land	34.50
Scientific Supplies	209.72
Scientific Equipment	42.50

TOTAL	\$16,822.00
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POTATO EXPERIMENT FUND

Appropriation	\$841.10
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Expended

Salaries	\$696.66
Labor	137.25
Heat, Light, Water, and Power	6.52
Transportation	.67

TOTAL	\$841.10
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POPULAR BULLETIN FUND

Appropriations	\$1,261.65
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Expended

Publications	\$1,261.65
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TOTAL	1,261.65
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SALES FUND (BROOKINGS STATION)

Balance on hand July 1, 1929	\$3,284.00
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Receipts Sales	6,352.63
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TOTAL	9,636.63
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EXPERIMENT STATION

35

	Expended	
Salaries	\$ 291.66	
Labor	1,401.29	
Stationery and Office Supplies	16.23	
Feeding Stuff	2,618.67	
Sundry Supplies	259.24	
Traveling Expense	174.52	
Transportation of things	133.92	
Heat, Light, Water, and Power	8.00	
Furniture and fixture	24.00	
Livestock	210.00	
Tools and Machinery	138.75	
Buildings and Land	625.00	
Contingent Expense	10.00	
TOTAL	\$5,911.28	5,911.28
Balance on hand June 30, 1930		3,725.35

TOTAL 9,636.63

LIVESTOCK EXPERIMENTAL REVOLVING

Balance on Hand July 1, 1929	\$765.63
November Cash Report	40.03
Total	\$805.66

	Expended	
Feeding Stuff	\$484.93	
Labor	214.50	
Sundry Supplies	1.95	
Transportation of things	30.00	
Total Expenditures	\$731.38	731.38
Balance on hand June 30, 1930		74.28

TOTAL 805.66

SUB STATION FUNDS

	Cottonwood	Eureka	Highmore	Vivian	Newell
Appropriation	\$2,716.75	\$2,716.75	\$2,716.75	\$2,716.75	2,000.00
	Expended				
Salaries	\$2,408.31	\$2,676.65	\$2,676.65	\$2,346.65	
Labor	197.33		5.50	254.70	610.50
Feeding Stuff				12.70	1,207.50
Sundry Supplies	41.53	25.94	25.00	17.53	96.32
Communication service		1.75	2.65	2.90	
Transportation of things	7.78	.14	.45	10.56	
Heat, Light, Water & Power	51.45	7.67	2.25	37.17	
Tools & Machinery	10.35	2.10	4.25	2.50	85.68
Publications		2.50			
Traveling Expense				32.04	
TOTAL	\$2,716.75	\$2,716.75	\$2,716.75	\$2,716.75	\$2,000.00

EXPERIMENT SUB STATION

Balance on hand July 1, 1930	\$ 8,279.01
Receipts from Land Rentals	5,005.58
Received from Sales of Produce	6,479.87
Total	\$19,764.46

	Expended	
Salaries	\$ 25.50	
Labor	3,377.31	
Stationery and Office Supplies	54.88	
Feeding Stuff	925.45	
Sundry Supplies	482.82	
Fertilizer	105.98	
Communication Service	71.80	
Traveling Expense	786.11	
Transportation of things	242.96	
Heat, Light, Water and Power	149.05	
Livestock	4,590.24	
Publications	13.00	
Tools and Machinery	923.40	
Buildings and Land	671.16	

Total \$12,419.16 \$12,419.16

Balance on hand June 30, 1930 7,345.30

TOTAL 19,764.46